

Electronic Teaching Files: Seven-Year Experience Using a Commercial Picture Archiving and Communication System

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With the advent of electronic imaging and the internet, the ability to create, search, access, and archive digital imaging teaching files has dramatically improved. Despite the fact that a picture archival and communication system (PACS) has the potential to greatly simplify the creation of, archival, and access to a department or multifacility teaching file, this potential has not yet been satisfactorily realized in our own and most other PACS installations. Several limitations of the teaching file tools within our PACS have become apparent over time. These have, at our facility, resulted in a substantially reduced role of the teaching file tools for conferences, daily teaching, and research purposes. With the PACS at our institution, academic folders can only be created by the systems engineer, which often serves as an impediment to the teaching process. Once these folders are created, multiple steps are required to identify the appropriate folders, and subsequently save images. Difficulties exist for those attempting to search for the teaching file images. Without pre-existing knowledge of the folder name and contents, it is difficult to query the system for specific images. This is due to the fact that there is currently no fully satisfactory mechanism for categorizing, indexing, and searching cases using the PACS. There is currently no easy mechanism to save teaching, research, or clinical files onto a CD or other removable media or to automatically strip demographic or other patient information from the images. PACS vendors should provide much more sophisticated tools to create and annotate teaching file images in an easy to use but standard format (possibly Radiological Society of North America's Medical Image Resource Center [MIRC] format) that could be exchanged with other sites and other vendors' PAC systems. The privilege to create teaching or conference files should be given to the individual radiologists, technologists, and other users, and an audit should be kept of who has created these files, as well as keep track of who has accessed the files. Vendors should maintain a local PACS library of image quality phantoms, normal variants, and interesting cases and should have the capability of accessing central image repositories such as the RSNA's MIRC images. Commercial PAC systems should utilize a standard lexicon to facilitate the creation and categorization of images, as well as to facilitate sharing of images and related text with other sites. This should be combined with a very easy to use mechanism to write images and related text when appropriate onto removable media (while maintaining a high level of security and confidentiality) to make it easier to share images for teaching, research, or clinical purposes.

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THE TRANSITION of an increasing number of radiology departments, hospitals, and outpatient centers from film-based to digital and filmless environments during the past several years has been associated with improvements in the speed and reliability of image access. Theoretically, this should also result in substantial improvements in the ease in which academic or teaching file cases are identified, created, organized, and retrieved. However, despite these theoretical advantages, we have found that this potential has not yet been satisfactorily realized in our own and most current commercial picture archival and communication systems (PACS).

SEVEN-YEAR EXPERIENCE WITH TEACHING FILES AT THE BALTIMORE VETERANS ADMINISTRATION MEDICAL CENTER

Our experience with academic or teaching file support by our vendor has been that it has been a valuable feature despite the limitations of the teaching file implementation on our PACS.

The academic or teaching file function is available to groups of radiologists and clinicians who are given access to this feature. The user can identify an entire study or selected images from a study for inclusion in a designated academic electronic "folder." These folders can be designed in a hierarchical manner, whereby folders can contain subfolders, which, in turn, can have subfolders themselves and so on. An example of typical folder, for example, might be Dr Reiner's Cases, which contains subfolders including interesting cases, research cases, and conferences. The interesting cases folder might contain anatomic categories such as neuroradiology, body imaging, musculoskeletal, modalities such as ultrasound, general

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radiology, and nuclear medicine, or pathologic entities such as interstitial lung disease, normal variants, and so on.

Retrieval of these academic folders is done in a manner similar to the way in which patient images are requested and displayed using the PACS in general. With the "central" database architecture of our PAC system (GE Medical Systems, Milwaukee, WI), images are retrieved from redundant array of inexpensive disks (RAID) directly to the "thin client" workstation without being written to the local hard drive. When images are designated as belonging to a "teaching file" the images themselves are not copied to a separate location. Instead, pointers to the images are stored in the PACS database under the designated electronic "academic" folder. When requested, the images are retrieved from either short-term storage on the RAID server (approximately 1/2 terabyte or approximately 2 months of images), which takes approximately 1 to 2 seconds, or if not retrieved recently, are transferred to the RAID from the optical jukebox, which typically occurs in approximately 30 seconds to 1 minute.

We have used teaching files for three major purposes: teaching and interesting case folders for academic purposes, conference folders for designated meetings such as tumor board or grand rounds, and research folders for review of images related to various departmental research projects.

Individual radiologists create teaching and academic files for a wide variety of purposes. One of the most commonly requested and utilized folders is an "interesting case" folder, which contains miscellaneous studies or images that are of interest typically due to the disease process, normal variant, due to the disease process, normal variant, excellent depiction of anatomy, or other academic or teaching value. Other folders are created according to anatomic region or imaging modality. Still other folders are utilized by our radiologists to form a repository of certain pathologic entities such as interesting cases of tuberculosis or lung cancer or of similar pathologic findings such as lung nodules.

Conference folders are used to organize cases for a scheduled conference or teaching session into an electronic directory. These act as electronic reminder lists of the cases scheduled for a conference and they also speed up the process of retrieval of these cases during the conference by obviating

the need to type in patient or study identification information manually during the conference in order to retrieve an examination. These folders permit users to make images available for review by participants and attendees prior to a scheduled conference such as grand rounds or clinical pathologic correlation conference or tumor board.

We use research folders to organize cases according to our various research protocols. For PACS workstation display studies, for example, we have found it helpful to organize imaging studies within a research folder in such a way to make it as fast as possible to present sets of images to our radiologists for evaluation and interpretation. Properly arranged using the teaching/research file function of the PACS, the time required to conduct the image interpretation timing or accuracy studies can be reduced by more than 50%.

Another use for these folders is as a repository of quality-control images or image phantoms. For example, we use the Society of Motion Pictures and Television Engineers (SMPTE) pattern as a test of our 1K and 2K monitors. These test patterns can be made available to all users conveniently in a quality-control/test-pattern folder.

Although we have found the PACS teaching file folder capability to be invaluable, there are a number of important limitations of the current version of our vendor's software. Unfortunately, these have, at our facility, resulted in a substantial reduction in the utilization of the teaching file tools, especially for conferences and academic purposes. One major limitation is the inability of the user to create his/her own teaching files. With our current PACS software, only the PACS system engineer has the ability to create new academic/teaching/research folders. This presents only a minor problem with research studies, which are always planned in advance, but often creates difficulties with conference or teaching folders. Additionally, once these folders are created, multiple keystrokes are required to identify the appropriate folders, and subsequently save images. The intuitive click and drag and drop approach to putting a case into a teaching folder is not supported and the process is not efficient.

Other difficulties exist for those attempting to access the various academic files. Without pre-existing knowledge of the folder name and contents, it is difficult to find desired cases. There is no mechanism to search for the various types of teach-

ing files in the system, nor is there a satisfactory mechanism to categorize and classify the cases that have been selected in such a way to make them available using a query or search mechanism. There is also no mechanism to protect conference or other teaching cases from being erased from the RAID server for a specified period of time. This would be helpful to ensure rapid retrieval for scheduled conferences in the future.

Once a teaching file case or case for publication is identified, there is currently no utility on our system to save teaching, research, or clinical files onto a R-W CD or other removable media. Additionally, there is no mechanism to "anonymize" or automatically strip demographic or other patient information from the images.

RECOMMENDATIONS

Based on our experience with the teaching files in our system, a relatively small number of improvements to the teaching file functions would result in a tremendous improvement in the utility of the PACS teaching file function. These include the following:

- The privilege to create teaching or conference files should be given to the individual radiologists, clinicians, technologists, and other users and an audit should be kept of who has created these files. It may be helpful to keep track (perhaps only by the creator of the original folder and system administrator) of which users have accessed the teaching folder.
- Vendors should provide tools to create and annotate teaching file images in an easy to use but standard format (hopefully RSNA MIRC format)
- It would be helpful to give certain users the ability to protect images in short-term storage (on the RAID) by specifying a time period during which teaching file cases would remain in short-term memory without being deleted.

The system administrator would monitor this feature.

- Vendors should maintain a local PACS library of image quality phantoms and test patterns.
- The PACS should be able to access the RSNA's MIRC over the internet or should at least be able to access a local or centralized vendor maintained library of teaching cases, normal variants and examples of normal anatomy.
- Vendors should utilize a standardized lexicon to help in the creation and categorization of images as well as to facilitate sharing of images and related text with other sites.
- There should be a very easy to use mechanism for users with the appropriate level of privileges to copy images and related text onto removable media (while maintaining a high level of security and confidentiality) to make it easier to obtain digital images for teaching, research, or clinical purposes.
- For research and conference purposes, it would be helpful to be able to set up a script that could be stored for presentation of certain images on workstations in a certain order with pre-set image processing. This would further reduce the number of keystrokes necessary for these functions even with the use of the academic folders.

CONCLUSION

It is very important for a PACS to provide strong support for a mechanism to create "academic" or other types of folders for clinical, administrative, academic, and research purposes. This function should be intuitive, easily available to authorized users and should require a minimum number of keystrokes. When implemented optimally, this will function as a powerful tool to promote sharing of important and interesting images.